367

Name of the Scholar: Riyaz Ahmed Bhat

Name of the Supervisor: Prof. Saeed Uddin

Department: Physics

Title of the Thesis: Hadron Spectra and Quark-Hadron Transition in Strongly Interacting Matter under Extreme Conditions

ABSTRACT

In the present work we have used a unified thermal model which employs the statistical approach of multi-particle production. In this model the hot and dense matter formed out of a nucleus-nucleus collision system is assumed to be in local thermal and chemical equilibrium at the time of freeze-out. This approach of ours has been very attractive and useful in understanding the different physics aspects expected to take place at different collider energies. Some of them are nuclear stopping (and or nuclear transparency) or early/later freeze-out depending up on the collider energy and the particle specie.

The present thesis entitled"*Hadron Spectra and Quark-Hadron Transition in Strongly Interacting Matter under Extreme Conditions*" is divided into 5 chapters:

The *first chapter* gives a very broad introduction of the particle physics and the physics of ultra-relativistic heavy ion collisions. It mainly focus on the specific issues of QCD for instance the properties of QCD like asymptotic freedom, quark confinement, bag model of hadrons, formation of QGP expected to happen at high baryon density or high temperature. A brief introduction of various Colliders is also discussed in this chapter. The remainder of this thesis is set out as follows:

In *second chapter* we present the results of identified hadron spectra in Au + Au collisions at the RHIC centre of mass energy of $\sqrt{s_{NN}} = 200$ GeV. Both longitudinal as well as transverse flow effects have been incorporated successfully in the model. The resonance decay contributions have also been added while calculating the spectra of various hadronic species. This way we have succeeded to give a satisfactory explanation to the rapidity spectra of various hadrons like protons, anti-protons, Kaons and anti-Kaons. The rapidity spectra of the heavy strange baryon ratios like $\overline{\Lambda}/\Lambda, \overline{\Xi}/\Xi$ have

also been reproduced. The transverse momentum distributions of all these hadrons and also the triply strange omega baryon have been also studied. The beauty of the model is that it provides the simultaneous fits of the rapidity as well as the transverse momentum distribution of the particles being studied.

In *Chapter 3* we have used the same unified thermal freeze-out model at different RHIC energies like $\sqrt{s_{NN}} = 200$ GeV, $\sqrt{s_{NN}} = 130$ GeV and $\sqrt{s_{NN}} = 62.4$GeV for gold-gold collisions. The transverse momentum distribution of almost all the hadronic species at different centralities at all the three RHIC energies is studied. The available rapidity distributions of some particles like the proton, anti-proton, Kaon, anti-Kaon etc., are studied for the most centrality in all the three cases. The transverse momentum distribution and the rapidity distribution of these particles have been fitted simultaneously for the most centrality by using single set of parameters for both the transverse momentum as well as rapidity distributions. By comparing the chemical potential parameterization parameters at different RHIC energies we could get insight of the transparency effects occurring at different RHIC energies. The sequential freeze-out of particles is also presented. The increasing profile of the collective flow velocity parameter with the centrality is also studied.

In *Chapter 4* we have studied the stability of quark gluon plasma droplets formed in a superheated hadronic medium at finite quark chemical potential. The finite size effects of the QGP droplet are taken into account. The relativistic density of states for quarks and gluons is constructed on the basis of Thomas-Fermi electronic model of atom and Bethe model of nucleons. The phenomenological flow parameters are incorporated in the model which takes into account the hydro dynamical flow effects. These phenomenological parameters for quarks are modified in the quark chemical potential dependent form. The finite sizes of hadrons are considered through the excluded volume effect. The strange quark chemical potential is calculated by using the strangeness conservation criteria of an ensemble of hadrons.

Finally, in the last chapter 5, overall summary and conclusions of the thesis is presented.